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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document identifies existing test methodology and techniques necessary to determine the degree to which aviation materiel meets the safety requirements stated in the requirements documents. These procedures cover the requirements, aircraft armament, airframe, ejection seat, electronic, mechanical, and miscellaneous hazards relating to Army aircraft. A guide for laser safety is included for use when lasers are mounted in Army aircraft.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

AD A110261

DRSTE-RP-702-106
*Test Operations Procedure 7-3-506 — 18 January 1982
AD No. A041021

SAFETY (AVIATION MATERIEL)

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1. SCOPE. To identify existing test methodology and techniques necessary to determine the degree to which aviation materiel meets the safety requirements stated in the requirements documents.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities. A typical Army airfield installation with appropriate maintenance hangar and shop facilities will be required.

CHARACTERISTIC	MINIMUM REQUIREMENT
Runway	As required.[1]
Shops	Engine, rotor, avionic electronics, sheet metal shop w/capability to perform GS level maintenance.

1. Technical Manual 5-330, Planning and Design of Roads, Airbases, and Heliports in Theater of Operations, 6 September 1968.

*This TOP supersedes TOP 7-3-506, Safety (Aviation Materiel), 9 Dec 76.

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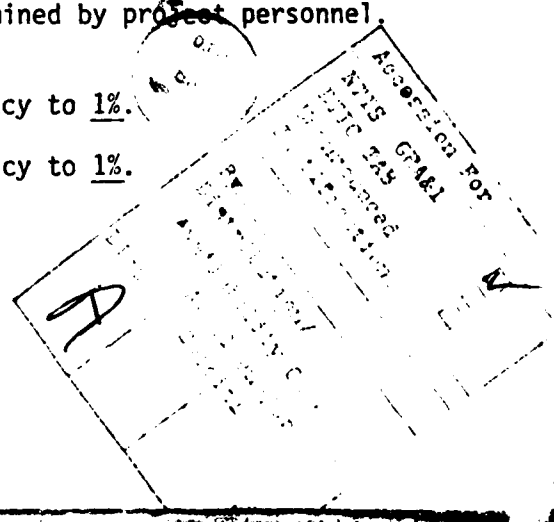
CHARACTERISTIC	MINIMUM REQUIREMENT
Office & Administration Work Area	Sufficient to accommodate the team.
Calibration Shop	Capable of calibrating maintenance tools & test equipment furnished to support the test item.

2.2 Equipment.

ITEM	MINIMUM REQUIREMENT
Standard Tools Set	Operator level, DS/GS level of maintenance authorized to support the test item.
Comparison Items	When specified.

2.3 Instrumentation.

ITEM	MINIMUM ACCURACY
Measuring and Recording Instrumentation	
a. Elapsed Time Meters	Rounding in hours and minutes and tenths of hours.
b. Event Counters	Measuring events or cycles of operations.
c. Test Measurement and Diagnostic Equipment	As stated in requirements document.
d. AC & DC voltmeters	Accuracy to 1%.
e. Ohmmeter	Accuracy to 1%.
f. Transducers, strain link, accelerometers, recording systems	2% accuracy unless otherwise determined by project personnel.
g. Weighing scales	Accuracy to 1%.
h. Thermometers	Accuracy to 1%.



ITEM	MINIMUM ACCURACY
Photography Equipment	
a. Standard Still Camera	
b. Standard & High Speed motion cameras	
c. Sound TV system with playback units	
Automatic Data Processing	
a. Instrumentation - IBM - 360-65 or terminal connected to an equivalent machine if warranted by workload of the project.	
b. Manual Collected Data - IBM - 360-65 or terminal connected to an equivalent machine if warranted by workload of the project.	

2.4 References.

a. Army Regulation 95-5, Aviation: Aircraft Accident Prevention, Investigation, and Reporting.

b. Army Regulation 385-16, System Safety.

c. Army Regulation 385-30, Safety: Safety Color Code Markings and Signs.

d. AMC Regulation 385-12, Safety: Life Cycle Verification of Safety.

e. DARCOM Supplement 1 to AR 385-16, System Safety.

f. DARCOM Regulation 385-29, Laser, and TECOM Supplement 1 thereto.

g. DARCOM Regulation 385-100, AMC Safety Manual.

h. TECOM Supplement 1 to AMCR 385-12, Life Cycle Verification of Materiel Safety.

i. TECOM Supplement 1 to AMCR 700-38, Test and Evaluation - Incidents Disclosed During Materiel Testing.

j. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.

k. TECOM Pamphlet 385-4, Laser Safety Primer.

l. MIL-STD-129, Marking for Shipment and Storage.

m. MIL-STD-130, Identification Marking of US Military Property.

n. TB MED 279, Control of Hazards to Health from Laser Radiation.

o. MIL-STD-454D, Standard General Requirements for Electronic Equipment.

p. MIL-STD-709, Ammunition Color Coding.

q. MIL-STD-800, Procedure for Carbon Monoxide Detection and Control in Aircraft.

r. MIL-STD-803, Human Engineering, Design Criteria for Aerospace Systems and Equipment.

s. MIL-STD-882A, System Safety Program Requirements.

t. TM-5-330, Planning and Design of Roads, Airbases, and Heliports in the Theater of Operations.

3. PREPARATION FOR TEST.

3.1 Facilities.

3.1.1 The test facilities should be in normal operating conditions with, as a minimum, those maintenance shops required tc support the test item equipped and functioning. Normal testing will be conducted at an established facility which will require a minimum preparation and/or set-up time.

3.1.2 In cases when testing is to be conducted at locations other than at the established facility, the required equipment and facilities not available at that location must be provided through coordination with appropriate agencies or shipped from the US Army Aviation Development Test Activity (USAAVNDTA), as applicable.

3.1.3 When testing is performed at other facilities, coordination and compliance with that facility's safety rules and regulations is required. Any equipment necessary to meet these requirements must be obtained.

3.2 Equipment (Test Item).

The test project manager/engineer and Aviation Safety officer should:

a. Review the test directive received from higher headquarters to gain a clear understanding of the test objectives and all accompanying safety instructions.

b. Conduct a thorough study of stated requirements as contained in the applicable requirements documents, Test Design Plan, Independent Evaluation Plan and the test directive to insure that complete and suitable test criteria have been selected.

c. Thoroughly study the materiel being tested and used for testing to include specifically, operational, technical and maintenance characteristics as may be pertinent to or affected by test item safety.

d. Test Safety. Plan for and schedule all test personnel for safety training to include familiarization with the following:

(1) Installation/disassembly safety procedures.

(2) Operation and maintenance safety precautions provided in the draft technical manuals.

(3) Safety precautions derived from the safety statements.

(4) Identification of hazards for which special precautions must be taken; i.e., protective clothing, masks, etc.

3.2.1 The initial inspection and operational checks will normally be conducted as part of the arrival inspection subtest for the item. However, project personnel must insure that, as a minimum, the checks outlined in Test Operations Procedure 7-3-503[2], Arrival Inspection/Preoperational Inspection (Aviation Materiel) are made if only a safety subtest is to be conducted.

3.2.2 When a reference or comparison item is used, subject it to the same tests as those applied to the test item.

3.3 Instrumentation.

3.3.1 Instrumentation should be checked for accuracy and calibrated prior to starting the test.

3.3.2 Plan for the use of photography whenever possible to illustrate findings and results of tests and to analyze system and personnel safety.

2. TOP 7-3-503, Arrival Inspection/Preoperational Inspection (Aviation Materiel.)

3.4 Data Required. Prepare record form for the systematic entry of data, chronology of test, and evaluation of the test item's safety using the checklists attached as Appendices A through F as guides.

4. TEST CONTROLS.

4.1 The great variety and complexity of aviation materiel makes it impractical to prepare an outline or procedure precisely matched to each commodity type or category. Test personnel in coordination with safety personnel shall delete or indicate "not applicable" those procedures, comments, or questions which do not apply to the item under evaluation.

4.2 These evaluations will be conducted, where applicable, when military operators and maintainers are utilizing the test item to assure system safety in the hands of the prospective users.

4.3 When determining potentially hazardous conditions, a qualitative measure of hazards stated in relative terms should be used to establish these hazards in the proper perspective. MIL-STD-882A[3] established such a measure by defining hazard levels as follows: Conditions such as personnel error, environment, design characteristics, procedural deficiencies, or subsystem or component failure or malfunction.

a. Category I - Catastrophic ... will cause death or severe injury to personnel, or system loss.

b. Category II - Critical ... will cause personnel injury or major damage, or will require immediate corrective action for personnel or system survival.

c. Category III - Marginal ... can be counteracted or controlled without injury to personnel or major system damage.

d. Category IV - Negligible ... will not result in personnel injury or system damage.

4.4 Materiel intended for military use should possess maximum safety characteristics consistent with the specified operational requirements. All hazards must be eliminated or adequately controlled.

5. SAFETY EVALUATION.

5.1 Objective. To determine hazardous conditions and unsafe features associated with the operation and maintenance of the test item.

3. MIL-STD-882A, System Safety Program Requirements, 28 Jun 77.

5.2 Standard. Extract from the appropriate requirements documents, or other policy criteria.

5.3 Method. Safety evaluation will be continuous throughout the test cycle in all configurations, terrain, and environmental conditions evaluated. All hazards must be eliminated or adequately controlled before safety confirmation can be provided. Apply applicable method from those listed below as they relate to the test item.[4] Safety hazards will be classified in accordance with TECOM TOP 1-1-012,[4] and MIL-STD-882A.[5]

5.3.1 Aircraft Armament Hazards.

a. Determine if the test can be conducted in accordance with the safety requirements contained in the various range regulations, safety regulations, and appropriate safety of flight release (Ref TECOM Supplement 1 to AMCR 385-12).[6]

b. Thoroughly inspect the test item(s), and perform operational testing, as required. During this period, consider the questions in Appendix A and complete the checklist.

5.3.2 Airframe Hazards. Conduct a technical inspection of the aircraft airframe to insure adherence to the standards and practices as established by applicable publications. The inspection will include a visual examination and, where required by instructions, a functional test with tools, gauges or test equipment. During this period, consider the questions listed in Appendix B and complete the checklist form.

5.3.3 Ejection Seat Hazards. Conduct a technical inspection of the ejection seat to insure adherence to the standards and practices as established by applicable publications. The inspection will include a visual examination and, where required by instructions, a functional test with tools, gauges, or test equipment. During this period, consider the questions listed in Appendix C and complete the checklist.

5.3.4 Electrical Hazards.

a. Examine all instructional and procedural material; determine the location of all possible electrical hazards and insure that these hazards are shielded or clearly indicated and that appropriate caution notices and instructions are provided.

4. TOP 1-1-012, Classification of Deficiencies and Shortcomings, 1 Apr 79.
5. MIL-STD-882A, System Safety Program Requirements, 28 Jun 77.
6. TECOM Supplement 1 to AMCR 385-12, Life Cycle Verification of Materiel Safety.

b. Evaluate all electrical conductors, junctions, switches, relays and breakers for current carrying capacity and rated voltage. Compare these capacities with voltage and current levels expected to be present during normal and emergency usage. Note any conditions where components ratings do not meet or exceed requirements. Assure that peak voltages and currents are within the maximum limits permitting safe operation.

c. Whenever doubt exists as to possible hazards, measurements shall be taken and testing accomplished as necessary to evaluate the condition.

d. Thoroughly inspect the test item(s), and perform operational testing, as required. During this period, consider the questions listed in Appendix D. Comments and answers should be based on the cumulative experience and observations of test personnel over the entire test period.

5.3.5 Mechanical Hazards.

a. Carefully examine all instructional material to determine the existence of any mechanical hazards.

b. Thoroughly inspect the test item(s) and perform preflight and postflight inspections, installation, operation, and maintenance testing, as required. Comments and answers should be based on cumulative experience and observation of test personnel over the entire test period. During this period, consider but do not be limited to, the questions in Appendix E and complete the checklist form.

5.3.6 Miscellaneous Hazards. Carefully examine all instructional material and the test item(s) to determine the existence of potential hazards not previously explored. Consider, but do not be limited to, the questions in Appendix F and complete the checklist form.

5.3.7 Laser and Night Vision Devices. Particular attention will be given to the safety evaluation of laser and night vision devices. Appendix G will be used as a guide to evaluate lasers and laser safety. The applicable portion of Appendix A through F should be used in preparing a safety checklist for evaluating night vision devices.

NOTE: A sample checklist form is contained as Appendix H. Similar forms should be developed as necessary using the questions in Appendix A through G as guides. Additional reference material to support this evaluation is contained in paragraph 2.4.

5.4 Data Required.

5.4.1 Record any problem encountered, training deficiency noted, or lack of experience with the utilization of military operation and maintenance which resulted in or could result in hazardous operations of the test item(s).

5.4.2 Detail answers to the various checklists used.

5.4.3 Identity of the various photographs.

5.4.4 Presence of any hazards in addition to those described in the checklists.

6. DATA REDUCTION AND PRESENTATION.

6.1 Review all data collected during completion of the various subtests, noting all safety information. Compare the data with safety requirements as specified in the appropriate requirements documents or other developmental criteria.

6.2 Evaluate each hazard found as to category in accordance with the information provided in paragraph 4.3.

6.3 Tabulate the hazards discovered together with identifying category number, associated test conditions, recommended corrective action, and identity of illustrative photographs.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: DRSTE-AD-M, Aberdeen Proving Ground, MD 21005. Technical information may be obtained from the preparing activity: Commander, US Army Aviation Development Test Activity, ATTN: STEBG-MP-QA, Fort Rucker, AL 36362. Additional copies are available from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, VA 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A

Aircraft Armament Hazards Checklist

Consider the following:

a. Fire Control Panel

(1) Is the panel located to allow the operator to effectively operate the armament subsystem simultaneously with flying the aircraft, yet not detract or interfere with flying the aircraft?

(2) Is the panel within functional reach of a 5th percentile aviator with shoulder harness locked, seat in position closest to the panel?

(3) Are there any switches within the panel that may be inadvertently placed ON?

(4) Does the function of each switch agree with the corresponding signal light?

(5) Are the colors used for each signal light appropriate?

(6) Are there any switches that require replacement with lock switches, covered with cover plates or secured with safety wire?

(7) Are the switching functions and signal lights compatible when more than one firing station is involved?

(8) Does the movement of each switch rheostat or indicator conform to human engineering principles?

(9) Is the correct nomenclature used for each function?

(10) Is there any conflicting and/or confusing nomenclature used?

(11) Is the lighting of the fire control panel adequate?

(12) Does the lighting allow ready identification of each switch rheostat and indicator?

b. Circuit Breaker Panel

(1) Is there a corresponding circuit breaker for each armament subsystem and/or firing station?

(2) Is each circuit breaker within reach of the operator and can it be activated while the operator is properly secured by the restraint system?

(3) Is the ease of operation of each circuit breaker adequate?

(4) Is the circuit breaker nomenclature compatible with the nomenclature used for each function within the fire control panel?

(5) Does the lighting allow ready identification of each circuit breaker?

c. Checklist

(1) Is a checklist desired to operate the armament subsystem?

(2) Is a checklist required to operate the armament subsystem?

(3) Is an operator's checklist provided for the armement subsystem?

(4) Are the functions and sequence of events contained on the operator's checklist adequate to operate the armament subsystem?

d. Jettison

(1) Are there primary provisions for release of external stores?

(2) Are there secondary (emergency) provisions for release of external stores?

(3) The primary type is:

Cartridge, hydraulic, plunger, spring, electrical, direct linkage/manual release, other. Is the primary release reliable?

(4) The secondary type is:

Cartridge, hydraulic, plunger, spring, electrical, direct linkage/manual pull, other. Is the secondary release reliable?

(5) Are pins, see-through windows or similar features required to determine unsafe conditions for the primary release?

(6) Are pins, see-through windows or similar features required to determine unsafe conditions for the secondary release?

(7) Is any personnel action required to close, cover or remove any item from the armament system or aircraft for the primary release prior to flight?

(8) Is any personnel action required to close, cover or remove any item from the armament system or aircraft for the secondary release prior to flight?

(9) Is the primary release control readily accessible to the operator?

(10) Is the secondary release control readily accessible to the operator?

(11) Is the reliability of the primary release subject to interference from environmental conditions such as ice, rust, sand, grit, etc?

(12) Is the reliability of the secondary release subject to interference from environmental conditions such as ice, rust, sand, grit, etc.?

e. Installation

(1) Can each externally mounted launcher, pod, rocket, missile, etc., be safely installed by personnel?

(2) Are adequate lifts or handholds provided for personnel?

(3) Is the weight and center of gravity of the externally mounted armament subsystem evenly distributed so not to overload one individual?

(4) Are any electrical, hydraulic, spring loaded devices or similar features required that might cause injury to personnel?

(5) Is mechanical equipment required to install the externally mounted armament subsystem?

(6) Can the installation be safely accomplished when using mechanical equipment?

(7) Are compatible handling features for the armament subsystem/mechanical equipment provided for installation?

(8) Are the aircraft bomb racks and the support lugs on the armament subsystem compatible?

(9) Are the aircraft and armament subsystem electrical adapters compatible?

f. Loading/Arming

(1) Does the externally mounted armament subsystem store stray voltage?

(2) Are grounding devices required?

(3) Are grounding devices provided? Do they comply with local procedures?

(4) Are any unsafe features or practices required of personnel to load or arm the armament subsystem?

(5) Are personnel required to pass in front of the loaded or armed armament subsystem or other armament subsystems when connecting/disconnecting the grounding equipment?

(6) Are personnel required to pass in front of the loaded or armed armament subsystem when connecting/disconnecting the aircraft battery?

(7) Are stow provisions for flexible armament subsystems adequate to permit safe loading/arming?

(8) Are the vertical/horizontal operating limits for flexible armament subsystems restricted to prevent injury to personnel or damage to equipment during ground operation?

(9) Are communications (using the aircraft power source) required between operator and support personnel during arming or static firing of the armament subsystem?

(10) Are communications (using the aircraft power source) provided?

(11) Are loading placards available and attached to armament subsystems?

(12) Are mechanical shielding devices used with armament subsystems to prevent injury in case of accidental firing?

g. Operational

(1) Are flight personnel required to ingress or egress in front of the armament subsystems after the system is loaded and/or armed?

(2) Are maintenance personnel required to pass in front of the armament subsystems after the system is loaded and/or armed?

(3) Is armor protection provided between ammunition compartment and flight personnel?

(4) Is the tension of each grenade ejector spring adequate to assure ejection from aircraft internal compartments when activated?

(5) Is asbestos shielding provided in the aircraft internal ammunition compartment?

(6) Is asbestos shielding required in the aircraft internal ammunition compartment?

(7) Are any aircraft electrical, hydraulic or fluid drain lines mounted through the internal ammunition compartment which may cause unsafe conditions?

(8) Is the aircraft provided with a shatterproof or bulletproof windshield to allow safe operation of the armament subsystem to V max?

(9) Does the operation of the armament subsystem affect the stability and/or control of the aircraft when firing symmetrically or asymmetrically during hover flight (helicopter only)?

(10) Does the operation of the armament subsystem affect the stability and/or control of the aircraft when firing symmetrically, asymmetrically, in coordinated and uncoordinated forward flight to V max?

(11) Can burning debris enter the crew compartment during flight when the armament subsystem is operated?

(12) Can gun gases or toxic fumes enter the crew compartment during flight when the armament subsystem is operated?

(13) Is the noise level harmful to personnel in the crew compartment when the armament subsystem is operated?

(14) Are the concussion effects harmful to personnel in the aircraft crew compartment when the armament subsystem is operated?

(15) Does any debris or structural damage result to the aircraft when the armament subsystem is operated?

(16) Should aircraft gravity force indicators be utilized when operating the armament subsystem?

(17) Should mirrors be installed on the aircraft to permit the armament subsystem to be observed during operation?

(18) Are the flight indicators static port located on the aircraft in an area that the indicators are affected by the concussion when the armament subsystem is operated?

(19) Does blindness or any other unsafe condition result to flight personnel from muzzle/rocket flash when the armament subsystem is operated during the hours of darkness?

(20) Can the intensity of the light within the sight reticle be reduced sufficiently to permit targets to be safely engaged during the hours of darkness?

(21) Are any undesirable light reflections, from the armament fire control and/or circuit breaker panels, visible in the crew compartment plexiglas canopy?

(22) Is expended brass/cartridges ejected from the aircraft while in flight?

(23) Would the ejected brass/cartridges be detrimental to friendly ground troops?

APPENDIX B

Airframe Hazards Checklist

Consider the following:

a. Prior to Test

(1) Does the aircraft have a safety-of-flight release for the flight envelope and all configurations to be investigated provided by the authorized civil or military engineering test agency according to the test directive?

(2) Has the aircraft received an acceptance inspection and test flight by qualified maintenance personnel?

(3) Are the aircraft records up-to-date, and do they reflect a safe, flyable condition?

b. Configuration

(1) Are all doors and hatches easy to open and close? Do they have dependable, durable latching devices?

(2) Are emergency exits jettisonable in one motion?

(3) If windows are considered an exit, are they blocked?

(4) Are all detachable pieces of equipment such as first aid kits, fire extinguishers, log books, fire axes, tiedowns, etc., secured satisfactorily?

(5) Are all crew and passenger seats positioned to provide easy access and exit, and with winter clothing and parachutes, as applicable?

(6) Are handholds and steps provided, and are they safe, if they are wet or icy?

(7) Does the restraining harness anchor to the basic aircraft structure, and does it possess a suitable inertia reel?

(8) Can the crew reach all necessary controls with the restraint harness locked?

(9) Are all controls and switches located so that the pilot can operate them comfortably, and do they generally conform with MIL-STD-250B?

(10) Will the flight controls operate in their full travel with all extremes of seat position and pilot size?

(11) Are all air ducts which may blow directly in the pilot's face protected from ingestion of dust and foreign objects? Do the air ducts obstruct the pilot's vision?

(12) Are the windshields and windows free from distortion areas?

(13) Do all controls, switches, and rheostats operate according to human factor engineering: (forward, upward, or clockwise is ON, OPEN, or INCREASE)?

(14) Are fuel and oil shutoff or other vital switches protected by safeguards?

(15) Is the cockpit and cabin area free from sharp projections which might harm occupants in the event of a crash or sudden stop?

(16) Do all vital controls have appropriate placards? Do the instruments have range markings and do they reflect the operating ranges and limits of the system(s) being monitored?

(17) Do trim position indicators correspond with the trim control and trim tab position?

(18) Do flaps position indicators correspond with the flaps control and flaps position?

(19) Are fuel system controls grouped on a fuel control panel, and are they satisfactorily placarded to avoid misuse?

(20) Are all warning lights grouped together in an annunciator-panel-type arrangement?

(21) Are fire extinguishing controls satisfactorily grouped and placarded?

(22) Are external stores releases properly safeguarded, and is a reliable emergency release provided?

(23) Are circuit breakers accessible, and are placards readable from the pilot(s) position(s)?

(24) Are at least two separate sources of attitude, heading, and altitude information provided?

(25) Does crew compartment lighting meet safety requirements (Human Engineering Lab (HEL) or US Army Aeromed Research Lab (USAARL) evaluation)).

(26) Does the aircraft conform to safety requirements according to the criteria documents?

(27) Are fire extinguishers immediately accessible and adequate?

(28) Does the aircraft meet safety-of-flight and crashworthiness criteria according to the US Army Safety Center (USASC) evaluation?

(29) Are oxygen provisions provided, and are they in operable condition?

(30) Are anti-icing and deicing systems provided, and are they in operable condition?

(31) Is anti-icing available on the FOD screen, if installed?

(32) Is weather avoidance radar provided and in operable condition?

(33) Is an aircraft environmental control unit provided and in operable condition to include windshield defrosting and defogging?

(34) Is a rain repellant system provided and in operable condition?

(35) Is an abbreviated takeoff and landing checklist located on the right of or adjacent to the instrument panel?

(36) Is a map case provided?

(37) Is a data case provided?

(38) Are relief tubes provided?

(39) Are ashtrays provided?

(40) Are control locks or rotor tiedowns provided?

(41) Are walkway danger areas (propellers, exhaust, etc.) painted red and placarded appropriately?

(42) Does the litter kit, if provided, possess adequate strength and dependable locking devices?

(43) Are cargo tiedown rings adequate with respect to strength and location and properly placarded as to weight limitations?

(44) Are troop seats adequate with respect to strength, safety belts, locking devices, and comfort?

(45) Are internal auxiliary fuel tanks properly secured and free from leaks?

(46) May any combination of passengers, cargo, external stores, fuel, and special equipment be carried without exceeding the c.g. location limits?

(47) Are access doors located to facilitate inspection and replacement of equipment?

(48) Are jacking attachments compatible with standard Army jacks and do they possess sufficient strength?

(49) Are hoisting provisions adequate with respect to location and strength?

(50) Has the fuel quantity gauge been calibrated by actual comparison with a fuel tanker truck meter?

(51) May propellers (fixed wing) be reversed in flight?

(52) May fuel boost pumps or transfer pumps be individually tested?

(53) Can any fuel cell be filled in order indiscriminantly, or must one cell be filled before another to allow maximum fuel accommodation?

(54) Is the engine air intake system provided with a filter device to remove dirt particles and other foreign objects?

(55) Are the rotor or propeller blades provided with hardened metal leading edges or other protective devices to reduce wear from impingement of sand and dust?

(56) Can the aircraft heater be operated on the ground to defrost the windshield before engine start?

(57) Are fuel vents and pitot tube heated?

(58) Are rearview mirrors provided where needed?

(59) Is a crash axe or knife stowed on board?

(60) Is an emergency static air system provided?

(61) Is the avionics safety checklist completed?

(62) Is the armament safety checklist completed?

c. Preflight

(1) Is the checklist current?

(2) Is the checklist adequate with respect to accuracy, content, and clarity when used as a guide in performing preflight checks?

(3) Are the following checks included as a minimum?

(a) Flight planning.

(b) Takeoff and landing data card.

(c) Weight and balance computation.

(d) Check that the c.g. and loading limitations are within limits for the configuration to be flown.

(e) Check that the fuel, oil, and special equipment are adequate for the mission to be accomplished.

(4) Complete Form F, DD Form 365F.

(5) Before exterior check:

(a) Publications (DA Form 2408-12, -13, -14, and 365F).

(b) Crew compartment area.

(c) Passenger/cargo compartment area.

(d) Aircraft systems (lighting, oxygen, etc.).

(6) Exterior check.

(7) Interior check.

(8) Before starting engine(s).

(9) Starting engine(s).

(10) Before taxiing.

(11) Engine(s) runup:

(a) Engine(s) checks.

(b) Aircraft systems operation checks.

(12) Before takeoff.

(13) Lineup or hover.

(14) After takeoff.

(15) Descent.

(16) Before landing.

(17) Landing.

(18) Go-around.

(19) After landing.

(20) Engine shutdown.

(21) Before leaving aircraft.

d. Emergency Procedures

(1) Are emergency procedures contained in the checklist adequate with respect to accuracy, content, and clarity?

(2) Are the procedures for the following included?

(a) Hot start.

(b) Engine fire during start.

(c) Engine failure.

(d) Propeller failure (fixed wing).

(e) Engine restart during flight.

(f) Systems failure (fuel, hydraulic, antitorque rotor, landing gear, etc.).

(g) Ditching.

(h) Bailout.

(i) External stores jettison.

(j) Fires during flight.

e. Operational Characteristics

(1) Is the noise level excessive (USAARL evaluation)?

(2) Are unusual or excessive vibrations of buffeting evident?

(3) Is the aircraft equally stable in all normal regimes of flight?

(4) Does varying the propeller or rotor rpm induce a significant change in attitude or control?

(5) Is the minimum control speed listed in the operator's manual conservatively accurate (fixed wing)?

(6) Are control forces caused by changes in speed, power setting, configuration (flap and gear (fixed wing)) light enough to be overcome with one hand?

(7) Are ailerons effective at speeds down to stall (fixed wing)?

(8) Is the crew and passenger compartment free from carbon monoxide fumes (USAARL evaluation)?

(9) Are any unusual or excessive vibrations present when design maximum speeds are flown for the various configurations according to the model specification?

(10) Do the flaps (fixed wing) retract at a speed that does not significantly affect the rate of climb during a go-around procedure?

(11) Are wing (fixed wing) ice lights provided?

(12) When not in operation, are windshield wipers out of the pilot's normal line of vision?

(13) Is an operable window provided to allow enough visibility for a landing in the event other windshield and windows are covered with ice?

f. Crashworthiness

(1) Has crashworthy design and material been incorporated in the airframe?

(2) Are the crew and troop seats crashworthy?

(3) Are litters crashworthy, if installed?

(4) Have crashworthy features been incorporated in the fuel system?

(5) Are restraint systems including shoulder harness and lap belt provided with a single-point release system?

(6) Is emergency flotation provided?

(7) Has non-lethal cockpit design been incorporated?

(8) Is adequate emergency evacuation provided?

APPENDIX C

Ejection Seat Hazards Checklist

1. Do ground lock safety pins lock the respective mechanisms when installed?

   Note: Perform this check with dummy cartridges installed.

2. With ground lock safety pins removed, do secondary lock (safety) mechanisms perform as intended?

   Note: Perform this check with dummy cartridges installed.

3. Can ejection system function without damage througout full travel of seat adjustment?

4. Are all restraint straps and harness adjusting mechanisms fully functional and adequate?

5. Do all firing cartridge installations have provisions for safety seals?

6. Do all devices not visible for daily inspection have provisions for application of safety seals?

7. Does emergency oxygen system operate on activation of seat firing mechanism?

   Note: Perform this check with dummy cartridges.

8. Can successful seat ejection sequence be accomplished if the canopy ejection malfunctions?

9. Are ground safety locks well identified as to installation position?

10. Are ground safety lock positions readily accessible for installation and removal?

11. Does the seat installation incorporate a time-release mechanism for separation from the occupant?

12. Are there provisions for automatic parachute deployment and seat separation that will function in the event of occupant incapacitation?

13. Are there provisions for the seat separation not occurring while excessive G-force is acting on the seat?

14. Are backup mechanical seat separation and parachute deployment mechanisms incorporated in the system?

15. Is a secondary means of firing the ejection mechanism available?

16. Does the seat incorporate restraining/positioning provisions for protection of the extremities?

APPENDIX D

Electrical Hazards Checklist

a. Consider the following:

(1) Is the main power breaker in an accessible location?

(2) Does main power breaker remove all power to the complete equipment/system?

(3) Does the design incorporate methods to protect personnel from accidental contact with voltages in excess of 30 volts while operating the complete equipment/system?

(4) Can power be removed when installing, replacing, or interchanging a complete equipment/system, assembly or part?

(5) Are all external parts, surfaces, and shields at ground potential at all times?

(6) Are antenna and transmission line terminals at ground potential except for radiated RF energy on their external surfaces?

(7) Is the impedance of the ground system sufficiently low to limit the potential above ground and to facilitate the operation of the over-current devices in the circuit?

(8) Are ground connections to shields and other mechanical parts, except the chassis and frame, made independently of electrical circuits?

(9) Is the path to ground from the equipment continuous and permanent?

(10) Does the ground have ample capacity to safely conduct any currents that shall be imposed upon it?

(11) Are ground test connectors provided?

(12) Can high voltage circuits and capacitors be discharged to 30 volts or less within a maximum of two seconds by automatic protective devices?

(13) Are all contacts, terminals and like devices having potentials in excess of 500 volts completely inclosed, interlocked and clearly marked: DANGER HIGH VOLTAGE?

(14) Are covers, structural members, and similar neutral parts of electrical systems grounded or protected from accidental contact by personnel or tools?

(15) Are energized components located or inclosed so that suitable protection is provided against contact with uninsulated items?

(16) Are components, conductors, and shielding appropriately located such that overheating, arcing, and shorting is avoided?

(17) Are interlocks, barriers, or guards provided in compartments having voltages in excess of 70 volts?

(18) Are assemblies or equipment operating in excess of 500 voltage completely enclosed and isolated and interlocked from the remainder of the assembly when located in the aircraft in which they are to be operated?

(19) Are safety switches provided which will deactivate associated mechanical drive units for the purpose of disconnecting these units without disconnecting other parts of the equipment?

(20) Are electrical connectors designed to insure that only the correct plug can be inserted in a receptacle or other mating unit?

(21) Where design considerations require plugs and receptacles of similar configuration, are mating plugs and receptacles suitably coded or marked?

(22) Is the equipment provided with sufficient caution plates to warn personnel of potential safety hazards?

(23) Are safety markings and warning placards conspicuous and placed in prominent positions wherever danger might be encountered?

(24) Do plugs and convenience outlets for use with portable tools and equipment have provisions for automatically grounding the frame or case of tools and equipment when the plug is mated with the receptacle?

(25) Are test points provided in equipment where measurements of potentials in excess of 1,000 volts are required?

(26) Are DC input power connections clearly marked for polarity?

(27) When equipment is designed to operate on more than one type of input power, are adequate precautions taken to prevent connection or use of improper power?

(28) Are safe grounding methods furnished?

(29) Are electrical enclosures suitable for their intended environment (watertight/splash proof/explosion proof)?

(30) Are mechanical and electrical interlocks designed to prevent energizing or movement when men are in positions where it could be dangerous?

(31) Does test item design allow for adequate cooling?

(32) Are wires and cables adequately supported and terminated to prevent shock and fire hazard?

(33) Are wires and cables properly protected at points where they pass through metal partitions?

(34) Do floor surfaces provide adequate insulating characteristics?

(35) Where capacitors are used, are suitable enclosures provided to prevent emission of flame or molten material in the event of a failure?

(36) Are controls located away from high voltage points?

(37) Are emergency controls placed in readily accessible positions?

(38) Do meters have protection against high voltage or current at the terminals?

(39) Are proper tools and test equipment furnished with the test item?

(40) Are noise levels and frequencies generated by operating equipment such that operator irritation or fatigue is caused?

(41) Is the equipment designed so that receptacles are "hot" and plugs are "cold" when disconnected?

(42) For terminal strips having potentials in excess of 30-volts rms AC or DC which might be accidentally contacted by the operator during off-cover operation, are slotted plastic covers provided which allow instrument probes to be inserted to the contacts or terminals?

(43) Is equipment protection provided for surges on power lines, interconnecting cables, and audio field wire connections due to lighting?

(44) Are primary service lines protected by overload protection devices?

b. Simulate or induce, one-by-one, all emergency conditions of equipment operation. Note any emergency condition not suitably monitored and safeguarded. Consider, but do not be limited by the following:

(1) Are suitable warning devices provided to indicate the approach of unsafe equipment operation?

(2) Are suitable alarm and/or shutdown devices provided to safeguard against operator injury and/or equipment failure?

(3) Do displays, which cannot be watched continuously, but require constant monitoring, have audible warning signals that are distinctive and unlikely to be obscured by other noises?

(4) Are critical warning lights isolated from other less important lights for best effectiveness?

(5) Are warning lights compatible with ambient illumination levels expected? (A dim light will not be seen in bright sunlight, and a bright light may be detrimental to dark adaptation.)

(6) Are the Army color and coding techniques utilized to define operating and danger ranges to simplify checkreading?

(7) Are all emergency systems completely independent of primary systems?

(8) Are control circuits and warning circuits designed so they are never combined?

(9) Are on-off or fail-safe circuits utilized wherever possible to minimize failures without operator knowledge?

APPENDIX E

Mechanical Hazards Checklist

Consider the following:

(1) Is the equipment provided with suitable carrying handles, lifting rings, and/or slings, tiedowns, etc.

(2) Is the weight distribution such that the equipment is easy to handle, move or position?

(3) Are equipment handles located over center of gravity whenever possible?

(4) Are handles recessed rather than extended where they might be hazardous?

(5) Are handles positioned so they cannot catch on other units?

(6) Are heavy parts located as close as possible to load bearing structures, and as low as possible?

(7) Is the equipment designed so that the center of gravity, and the configuration of tiedowns and rings make the equipment unlikely to tip over from any flight conditions?

(8) Have sharp or overhanging edges and corners that may cause injury to personnel been eliminated?

(9) Are edges of components and maintenance access openings rounded or protected by rubber, fiber, or plastic protectors to prevent personnel injury?

(10) Are doors and other openings with their catches, hinges, supports, fasteners, and stops designed to minimize the possibility of injury to personnel?

(11) Is it evident when a cover is in place but not secured?

(12) Is fastening adequate to insure rigidity and satisfactory holding ability?

(13) Do hatches have a positive lock for the open position, and is this lock simple to operate and capable of withstanding all the rigorous requirements of a tactical vehicle in a combat situation?

(14) Are struts and latches provided to secure hinged and sliding components against accidental movement which could cause injury to personnel during maintenance operations?

(15) Are limit stops provided on drawers or foldout assemblies that could cause personnel injury if not restrained?

(16) Are conspicuous placards mounted adjacent to very hot equipment?

(17) Do switches or controls which initiate hazardous operations, such as ignition, etc., require the prior operation of a related or locking control?

(18) Are mechanical components which require use of heavy springs designed so that the spring cannot be inadvertently dislodged and cause personnel injury or damage to component?

(19) Are warning plates provided where mechanical assemblies, linkages, springs, etc., are under constant strain or load?

(20) Are wires and cables adequately supported through mechanical means and terminated to prevent shock and fire hazard?

(21) Are expandable and collapsible structures such as shelters, jacks, supports, masts, tripods, etc., designed to prevent possible injury to personnel?

(22) Are fastenings and methods of securing equipment to frames and racks sufficiently strong to prevent breakaway and falling?

(23) Are steps and ladders, and methods of fastening and supporting them safe?

(24) Do floor surfaces provide adequate nonslip characteristics?

(25) Does test item design provide for the necessary access and egress? Insure that all routes and exits are properly labeled.

(26) Are access doors made whatever shape is necessary to permit passage of components and implements which must pass through?

(27) Can equipment or aircraft shelter be entered without encountering hazards (i.e., guy wires, cables, low headroom and obstruction to entrance)?

(28) Is air that is used for equipment cooling completely isolated so as to prevent contamination of air around personnel?

(29) Does the ventilating system provide for operator comfort by ducting the excess heat dissipated by equipment to the outside?

(30) Is the ventilating system exhaust located so as to not contaminate intake air?

(31) When internal combustion engines are a part of the equipment, are the exhausts routed properly to prevent a concentration of carbon monoxide in the compartment of aircraft?

(32) Are exhausts for systems designed so that gases are directed away from the aircraft enclosure or compartment?

(33) Are systems and equipment properly secured to prevent possible accidents when the aircraft is in motion?

(34) Does the installation of equipment on the aircraft provide sufficient mechanical strength to minimize potential hazards?

(35) If a standard military aircraft has been modified, is the aircraft still capable of satisfactory and safe operation?

(36) Are safety measures provided in the event the system or equipment becomes detached from the aircraft?

(37) Do exposed gears, cams, levers, fan, belts, and bell cranks have adequate safety covers?

(38) Have fire hazards been kept to a minimum?

(39) Are portable, hand-operated fire extinguishers provided where fire hazards exist or may be created, and are they of the correct type?

(40) Are fire extinguishers and extinguishing systems placed where they are readily accessible, but not immediately adjacent to points where fire would probably originate?

(41) Where test item design includes the use of pressurized systems and components, insure that safety and/or relief valves, controls and other safety features are provided, as appropriate.

(42) Insure that safety valves, relief valves or other safety devices are adjusted to their proper setting.

(43) Insure that safety valve/relief valve discharges are run so as to avoid danger to personnel.

(44) Where appropriate, does equipment design include positive stops, torque limiting devices, safety links, fuze plugs, and/or quick release or disconnect features?

(45) When required, are provisions made for protection against eye hazards from flying particles?

(46) When glass is used, is it glareproof and shatterproof?

(47) Are any components mounted such that vision is obstructed?

(48) Has proper material been used in construction of the item? Consider the following:

(a) Hardness

(b) Temper

(c) Compatibility

(d) Toxicity

(e) Fire retardant characteristics

(f) Strength

(g) Weight and center of gravity

(h) Other, as appropriate

(49) Are potential mechanical hazards adequately treated in the draft instruction manual?

(50) Are all system shutoffs in the cabin compartment clearly placarded?

(51) Are proper tools and test equipment furnished with the test item?

APPENDIX F

Miscellaneous Hazards Checklist

Consider the following:

(1) Are fire and explosion hazards properly safeguarded?

(2) Are dangerous fuels, cleaning fluids, acids, caustics, solvents, agents, and other harmful chemicals properly marked, stored and handled?

(3) Are suitable safeguards provided for detection and elimination of toxic dusts, gases, fumes, and mists?

(4) Are appropriate measures taken to protect personnel from visible and invisible high intensity light sources?

(5) Is the test item properly designed to prevent operator fatigue induced by poorly positioned or designed controls and monitoring devices?

(6) Are psychological hazards minimized? Such hazards may be induced by unorthodox positioning of common controls or requiring unusual manipulative actions to perform ordinary tasks.

(7) Are properly marked, positioned, and unobstructed fire exits provided?

(8) Are protective devices and warning signs provided against all sources of potentially dangerous radiant energy (ultraviolet, microwave, x-ray, gamma)?

(9) Are all requirements for protective clothing explicitly noted?

(10) Are all limitations in equipment usage clearly defined?

(11) Are warning signs coded and colored in accordance with Army Regulation 385-30?

(12) Are all safety requirements of applicable specifications or technical requirements complied with?

(13) Check fuel, oil, and hydraulic systems for hazards.

(14) Are proper fuel and oil fittings and lines for the specific application used?

(15) Are lines routed and secured in a manner that eliminates chafing?

(16) Are lines routed and positioned so normal operation and maintenance functions can be performed without placing stress on them?

(17) Are lines routed to avoid areas of high temperature?

(18) Are lines routed to avoid fire hazards in the event of a rupture?

APPENDIX G

LASER SAFETY GUIDE

A. POLICY

1. All laser type devices operated for the first time or incorporated into military equipment for the first time or operated in a manner materially different from the norm, must be safety inspected by a representative of the Army Environmental Hygiene Agency, Edgewood, MD. It is also recommended that those activities having radiation protection committees cause those or similar committees to review and approve such laser tests and related laser SOP's prior to actual laser use.

2. All laser operators and other personnel who could reasonably be exposed to harmful energy levels of laser beams, will be given an eye examination as deemed adequate by the local surgeon prior to actual exposure. Results of this eye examination will become a part of the individual's permanent health record and will include, if practicable, the following:

a. Uncorrected vision

b. Corrected vision

c. Color perception

d. Visual fields

e. Slit-lamp examination

f. Color photography of the retina (if available)

3. All personnel who could reasonably be exposed to harmful energy levels of laser beams will wear laser glasses which shall possess printing on the eyewear indicating the optical density of the glasses at appropriate laser wavelengths for which the glasses offer protection. Example:

OD 4 at 1064NM

4. Protection Standards. Figure 1 presents the protection standards for typical lasers used in military applications.

**** PROTECTION STANDARDS FOR TYPICAL LASERS USED IN MILITARY APPLICATIONS

Type of Laser	PRF	Wavelength (nm*)	Exposure Duration	Protection standard for intrabeam viewing by the eye
Single-Pulse Ruby Laser Range Finder	Single Pulse	694.3	1 ns-18 us	5×10^{-7} J/cm^2/pulse
Repetitively Pulsed Ruby	10 Hz**	694.3	1 ns-18 us	1.6×10^{-7} J/cm^2/pulse
Laser Range Finders and Designators	20 Hz	694.3	1 ns-18 us	1.1×10^{-7} J/cm^2/pulse
Single-Pulse Neodymium Range Finder	Single Pulse	1060	1 ns-100 us	5×10^{-6} J/cm^2/pulse
Repetitively Pulsed Neodymium	10 Hz	1060	1 ns-100 us	1.6×10^{-6} J/cm^2/pulse
Range Finders and Designators	20 Hz	1060	1 ns-100 us	1.1×10^{-6} J/cm^2/pulse
CW Argon Lasers	CW***	488 and 514.5	0.25 s	2.5 mW/cm^2
CW Argon Lasers	CW	488 and 514.5	4 to 8 hours	1 uW/cm^2
CW Helium-Neon Lasers (for Alignment, etc.)	CW	632.8	0.25 s 4 to 8 hours	2.5 mW/cm^2 1 μW/cm^2
CW Neodymium YAG Laser	CW	1064	100 s-8 hours	0.5 mW/cm^2
Erbium Laser Range Finder or Designator	Single Pulse	1540	1 ns-1 us	1 J/cm^2/pulse
Holmium Laser Range Finder	Single Pulse	2010	1 ns-100 ns	10^{-2} J/cm^2/pulse
CW Carbon-Dioxide Laser	CW	10,600	10 s-8 hours	0.1 W/cm^2
CW Carbon-Monoxide Laser	CW	4700	10 s-8 hours	0.1 W/cm^2

*nm = Nanometers = 10^{-9} meter
**10 Hz = 10 pulses per second
***CW = continuous wave laser, emitting for a period in excess of 0.25 second
****Standards were taken from TECOM Pamphlet 385-4, page 8-3

Figure 1
G-2

B. EXPOSURE CONTROL.

Control of occupational hazards incidental to the user of lasers must be aimed at maintaining exposures not greater than the maximum permissible level. Potential occupational hazards include damage to the eyes and skin, "burns" from contact with liquid nitrogen or other substances used as coolants, electrical shock, exposure to gases such as ozone, and explosions at capacitor banks, optical pump system and target area. A complete safety program must be maintained for the protection of operating personnel and such other persons as may be required to be present at laser installations. When indicated, the following controls should be provided as well as any others that may be indicated by the nature of the operation. Provision of a closed installation is desirable. The equivalent of a closed installation can be achieved by installing a laser in a light-proof enclosure. Where neither of these alternatives are followed, an open installation results and the following safeguards should apply:

1. General Precautions Applicable to All Laser Installations:

a. Looking into the primary beam and at specular reflections of the beam must be avoided when power or energy densities exceed the maximum permissible exposure levels.

b. Aiming the laser with the eye should be avoided to prevent looking along the axis of the beam, which increases the hazard from reflections.

c. Safety eyewear designed to filter out the specific frequency characteristics of the system affords partial protection. Safety glasses should be evaluated periodically to insure maintenance of adequate optical density at the desired laser wavelength. There should be assurance that laser goggles designed for protection from specific lasers are not mistakenly used with different wavelength lasers. Laser safety glasses exposed to very intense energy or power density levels may lose effectiveness and should be discarded.

d. The laser beam should be terminated by a material that is nonreflective and fire resistant, and an area should be cleared of personnel for a reasonable distance on all sides of the anticipated path of the laser beam.

e. Suitable precautions to avoid electrical shock should be followed in connection with the potentially dangerous electrical circuits (both high and low voltage).

2. Special Precautions for High Powered Pulsed Lasers.

a. Safety interlocks at the entrance of the laser facility should be so constructed that unauthorized or transient personnel are denied access to the facility while the laser power supply is charged and capable of firing.

b. Laser electronic-firing systems should be so designed that accidental pulsing of a stored charge is avoided. The design should incorporate a "fail-safe" system.

c. An alarm system including a muted sound, flashing lights (visible through laser safety eyewear) and a countdown is advisable once the capacitor banks begin to charge.

d. Installations using liquid nitrogen coolant should be adequately ventilated.

e. Walls and ceiling should be painted with diffuse non-gloss paint, preferably black near the target area, and light color elsewhere to increase ambient light level.

f. Where feasible, solid-state lasers such as ruby pulsed devices, because of their higher power output (megawatt and gigawatt range), should be operated by remote control firing with television monitoring which eliminates the requirement for personnel to be in the same room with the laser. An alternative is to enclose the laser and beam within a light-tight box.

3. Special Precautions for Low Powered Gas C.W. and Semi-Conductor Lasers.

It is especially important to avoid the hazard during the alignment of the beam by eye and from specular reflection.

a. The use of a diffuse matte to position the beam is inadvisable, but the matte should be of such a color or reflectivity as to minimize reflection while still making the beam visible.

b. Elimination of all reflective material from the area of the beam (good housekeeping) is essential.

c. High powered gas and semi-conductor lasers are to be treated as pulsed lasers unless otherwise specified.

4. Carbon Dioxide - Nitrogen (CO_2 - N_2) Gas Lasers.

a. The principal hazard associated with the CO_2 - N_2 lasers is the fire hazard. A sufficient thickness of firebrick or asbestos should be provided as a backstop for the beam.

b. The laser assembly should be constructed of a material opaque to ultraviolet light generated by the gas discharge. Quartz tubing transmits ultraviolet light, whereas certain heat-resistant glass tubing is reasonably opaque at this part of the spectrum.

c. Reflections of the infrared laser beam should be attenuated by enclosure of the beam and target area or by eyewear constructed of a material opaque to the CO_2 wavelength, such as plexiglass.

5. Additional Precautions for Lasers in an Outdoor Environment.

a. Personnel must be excluded from the beam path to a distance where power or energy density is within acceptable levels. This may be accomplished by use of physical barriers, administrative control, interlocks and limiting beam traverse.

b. The inadvertent or intentional tracking of non-target vehicular traffic or aircraft must be prohibited if within calculated hazardous distance. Mountains and hills serve as excellent backstops for laser beams.

c. Operation of the laser in rain, snow, fog or dust produces a hazard distance of one meter.

d. The beam path should be cleared of all objects capable of producing potentially hazardous reflections. Lasing at or near populated areas should be avoided.

6. Personnel Protective Equipment.

a. Personnel exposed to laser beams must be furnished suitable laser safety goggles of optical density (O.D.) adequate for the energy involved. The following table lists the maximum power or energy density for which adequate protection is afforded by glasses of optical densities from 1 through 8. This table is based on the maximum permissible exposure levels for a dark adapted eye.

TABLE G-1

Attenuation of Laser Safety Glass

O.D.	db Attenuation	Attenuation Factor	Q-switch Max. Energy Density (j/cm^2)	Non-Q- Switch Max. Energy Density (j/cm^2)	C.W. Max Power Density ($watts/cm^2$)
0	0	0	10^{-8}	10^{-7}	10^{-6}
1	10	10^{2}	10^{-7}	10^{-6}	10^{-5}
2	20	$10+^{3}$	10^{-6}	10^{-5}	10^{-4}
3	30	$10+^{4}$	10^{-5}	10^{-4}	10^{-3}
4	40	$10+^{5}$	10^{-4}	10^{-3}	10^{-2}
5	50	$10+^{6}$	10^{-3}	10^{-2}	10^{-1}
6	60	$10+^{7}$	10^{-2}	10^{-1}	1.0
7	70	$10+^{8}$	10^{-1}	1.0	10
8	80		1.0	10	100

b. Exposure of the skin of personnel should be protected by the use of protective gloves where only the hands are to be involved. Where other than the hands will be exposed, protective coverings or shields should be used. The face should be turned away from the target area. Laser welding facilities must have sufficient shielding surrounding the article being welded.

c. Impervious, quick-removal type gloves, face shields and safety glasses must be provided as minimum protection for personnel who handle the extremely low temperature liquid coolants used in higher powered lasers.

C. VARIATION IN LASER SYSTEMS.

Of paramount importance to personnel concerned with lasers is the need to recognize the variations in laser systems, their operation and inherent hazards. Because the hazards vary with particular laser systems, each system must be analyzed in detail by competent personnel in order to establish precise safe operating procedures.

D. REQUEST FOR TECHNICAL ASSISTANCE.

Assistance in evaluating potential health hazards to Army personnel from the operation of testing of laser equipment is available from the U. S. Army Environmental Hygiene Agency, Edgewood Arsenal, MD 21010. This agency maintains a capability for investigating and evaluating health hazards associated with the use of this equipment. The services of the agency are available upon request to Headquarters TECOM, ATTN: DRSTE-ST.

E. WARNING SIGNS.

Evaluation of each anticipated operating condition should include consideration and development of procedures for insuring proper placing of warning signs for that operation. Standard operating procedures should prescribe procedures for the placement of temporary or permanent signs during each period of operation. A sign such as shown in Figure 2 should be used.

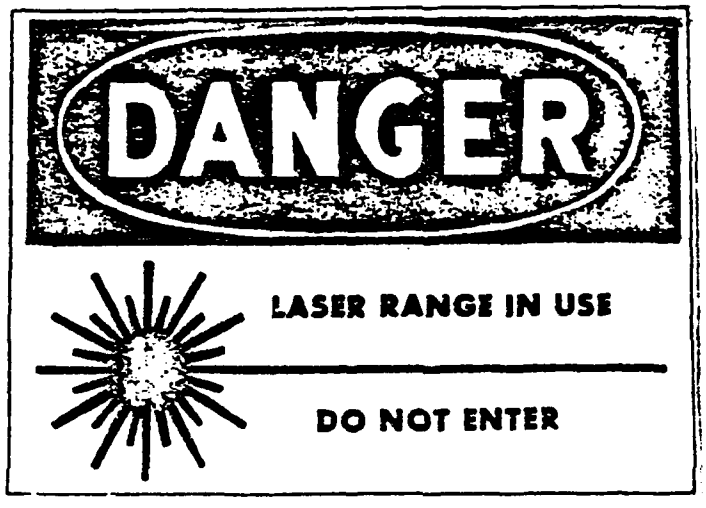


Figure 2

APPENDIX H

SAMPLE CHECKLIST

A. ELECTRICAL HAZARDS

Consider the following:

	YES	NO	REF
1. Are all switches, rheostats, indicators, circuit breakers, and fuses adequately identified?			
2. Are all switches located or positioned to prevent being inadvertently placed ON?			
3. Does the function of each switch agree with the corresponding signal light?			
4. Are direct current (d.c.) input power connections clearly marked for polarity?			
5. Is the main circuit breaker located in an accessible location?			
6. Is each circuit breaker within reach of the operator?			
7. Is the ease of operation of each circuit breaker adequate?			
8. Are ground test points available and readily accessible?			
9. Does the main power breaker remove all power to the complete equipment/system?			
10. Does the design incorporate methods to protect personnel from accidental contact with voltages in excess of 30 volts while operating a complete equipment/system?			
11. Can power be removed when installing, replacing, or interchanging a complete equipment/system, assembly, or part?			
12. Are energized components located or enclosed so that suitable protection is provided against contact with uninsulated items?			

	YES	NO	PEF
13. Are electrical connectors designed to insure that only the correct plug can be inserted in a receptacle or other mating unit?			
14. Where design considerations require plugs and receptacles of a similar configuration, are mating plugs and receptacles suitably coded or marked?			
15. Are safe grounding methods furnished?			
16. Are electrical enclosures suitable for their intended environment (water-tight/splash proof/explosion proof)?			
17. Are mechanical and electrical interlocks designed to prevent energizing or movement when men are in positions where it could be dangerous?			
18. Does test item design allow for adequate cooling?			
19. Are wires and cables adequately supported and terminated to prevent shock and fire hazards?			
20. Are wires and cables properly protected at points where they pass through metal partitions?			
21. Are potential electrical hazards adequately treated in the draft instruction manual?			
22. Are noise levels and frequencies generated by operating equipment minimized to prevent operator irritation or fatigue?			
B. OTHER HAZARDS			
Consider the following:			
1. Are edges of components and maintenance access openings rounded or protected by rubber, fiber, or plastic protectors to prevent injury to maintenance personnel?			

	YES	NO	REF
2. Have sharp or overhanging edges and corners that may cause injury to personnel been eliminated?			
3. Are doors and other openings with their catches, hinges, supports, fasteners, and stops designed to minimize the possibility of injury to personnel?			
4. Is it evident when a cover is in place but not secured?			
5. Are fasteners adequate to insure rigidity and satisfactory holding ability?			
6. Are limit stops provided on drawers or foldout assemblies that cause personnel injury if not restrained?			
7. Are fasteners and methods of securing equipment to frames and racks sufficiently strong to prevent breakaway and falling?			
8. Is the equipment designed so that the center of gravity does not make the equipment likely to tip over?			
9. Are warning placards conspicuous where mechanical hazards exist?			
10. Are potential mechanical hazards adequately treated in the draft instruction manual?			
11. Have fire hazards been minimized?			
12. When glass is used, is it glareproof?			